

**Technical training.**  
Product information.

## **F12 Powertrain**



**BMW Service**

Edited for the U.S. market by:  
**BMW Group University**  
Technical Training

ST1103

5/1/2011

## General information

### Symbols used

The following symbol is used in this document to facilitate better comprehension or to draw attention to very important information:



---

Contains important safety information and information that needs to be observed strictly in order to guarantee the smooth operation of the system.

---

### Information status and national-market versions

BMW Group vehicles meet the requirements of the highest safety and quality standards. Changes in requirements for environmental protection, customer benefits and design render necessary continuous development of systems and components. Consequently, there may be discrepancies between the contents of this document and the vehicles available in the training course.

This document basically relates to the European version of left hand drive vehicles. Some operating elements or components are arranged differently in right-hand drive vehicles than shown in the graphics in this document. Further differences may arise as the result of the equipment specification in specific markets or countries.

### Additional sources of information

Further information on the individual topics can be found in the following:

- Owner's Handbook
- Integrated Service Technical Application.

Contact: [conceptinfo@bmw.de](mailto:conceptinfo@bmw.de)

©2010 BMW AG, Munich

### Reprints of this publication or its parts require the written approval of BMW AG, München.

The information contained in this document forms an integral part of the technical training of the BMW Group and is intended for the trainer and participants in the seminar. Refer to the latest relevant information systems of the BMW Group for any changes/additions to the technical data.

Status of the information: **November 2010**  
VH-23/International Technical Training

# F12 Powertrain

## Contents

<b>1. Drivetrains</b>	<b>1</b>
1.1. Models	1
1.1.1. Gasoline engines	1
1.2. Further information	2
<b>2. Engine</b>	<b>3</b>
2.1. N63 engine	3
2.1.1. Technical data	4
2.1.2. Full load diagram	5
2.2. Engine designation and engine identification	6
2.2.1. Engine designation	6
2.2.2. Engine identification	7
<b>3. Automatic transmission</b>	<b>8</b>
3.1. Designation	8
3.2. Variants	8
3.3. GA8HP transmission	8
3.3.1. Technical data	10
3.4. Transmission emergency release	10
3.4.1. Mechanical transmission emergency release	10
3.4.2. Electronic transmission emergency release	12
3.5. Gear selector switch	13
<b>4. Manual transmission</b>	<b>14</b>
4.1. Designation	14
4.2. Variants	14
4.3. G manual transmission	14
4.3.1. Technical data	15
4.4. Gearshift	16
<b>5. Rear axle final drive</b>	<b>17</b>
5.1. Designation	17
5.2. Variants	17
5.3. Lightweight construction, rear axle final drive	17
<b>6. Driveshafts</b>	<b>18</b>
6.1. Driveshaft	18
6.1.1. Overview	18
6.1.2. Crash function	19
6.2. Output shafts	19
6.2.1. Designation	19

# F12 Powertrain

## Contents

6.2.2.	Variants.....	19
6.2.3.	Overview.....	19

# F12 Powertrain

## 1. Drivetrains



TA09-1401

F12 Drive

### 1.1. Models

#### 1.1.1. Gasoline engines

	<b>640i (available 9/2011)</b>	<b>650i</b>
Engine	N55B30M0	N63B44O0
Power KW/bhp	235/315	300/402
Torque Nm/ ft-lbs	450/331	600/443
Exhaust emission standards	ULEVII	ULEVII
Manual gearbox	N/A	GS6-53BZ
Automatic transmission	GA8HP45Z	GA8HP70Z
Rear axle final drive	HAG 205AL	HAG 225AL

# F12 Powertrain

## 1. Drivetrains

### 1.2. Further information

The descriptions of the engines and the eight-speed automatic transmission can be found in the following technical training manuals:

- ST916 N55 engine
- ST610 covers the N63 engine
- ST914 F07 covers the GA8HP Automatic Transmission.

# F12 Powertrain

## 2. Engine

### 2.1. N63 engine



N63 engine

First introduced with the X6, the N63 engine is the successor to the N62 engine. It is the first engine worldwide to feature an optimized package for integration of the turbochargers and main catalytic converters within the engine valley. The location of the turbochargers and catalytic converters (in the “v” space between the banks) means the locations of the intake and exhaust ports have been reversed. In addition, the resulting short pipe lengths and large cross-sections minimize the pressure losses on the intake and exhaust ports.

#### Special features:

- Implementation in all model series (E71/E72, F01/F02, F04, F07/, F10)
- Twin exhaust turbochargers in the engine valley
- Catalytic converters are also mounted in the engine valley
- High Precision Direct fuel injection with piezoelectric injectors
- MSD85 engine control, liquid-cooled and FlexRay capable
- Indirect charge air cooling

# F12 Powertrain

## 2. Engine

### 2.1.1. Technical data

		<b>N62B4801 E64, 650i</b>	<b>N63B4400 F12, 650i</b>
Design		V8	V8
Valves per cylinder		4	4
Engine control		ME9.2.3	MSD85
Displacement	[cm <sup>3</sup> ]	4799	4395
Stroke/bore	[mm]	88.3/93.0	88.3/89.0
Power output at speed	kW/bhp [rpm]	270/367 6300	300/400 5500 - 6400
Torque at speed	Nm/ft-lbs [rpm]	490/361 3400	600/450 1750 – 4500
Compression ratio	[ε]	10.5 : 1	10.0 : 1
Fuel grade		ROZ 91 – 98	ROZ 91 – 98
Exhaust emission standards		ULEV II	ULEV II
Fuel consumption complying with EU combined (manual/automatic transmission)	[l/100 km]	12.6/10.9	-/10.7
Acceleration 0 – 100 km/h (manual/automatic transmission)	[s]	5.5/5.6	5.0

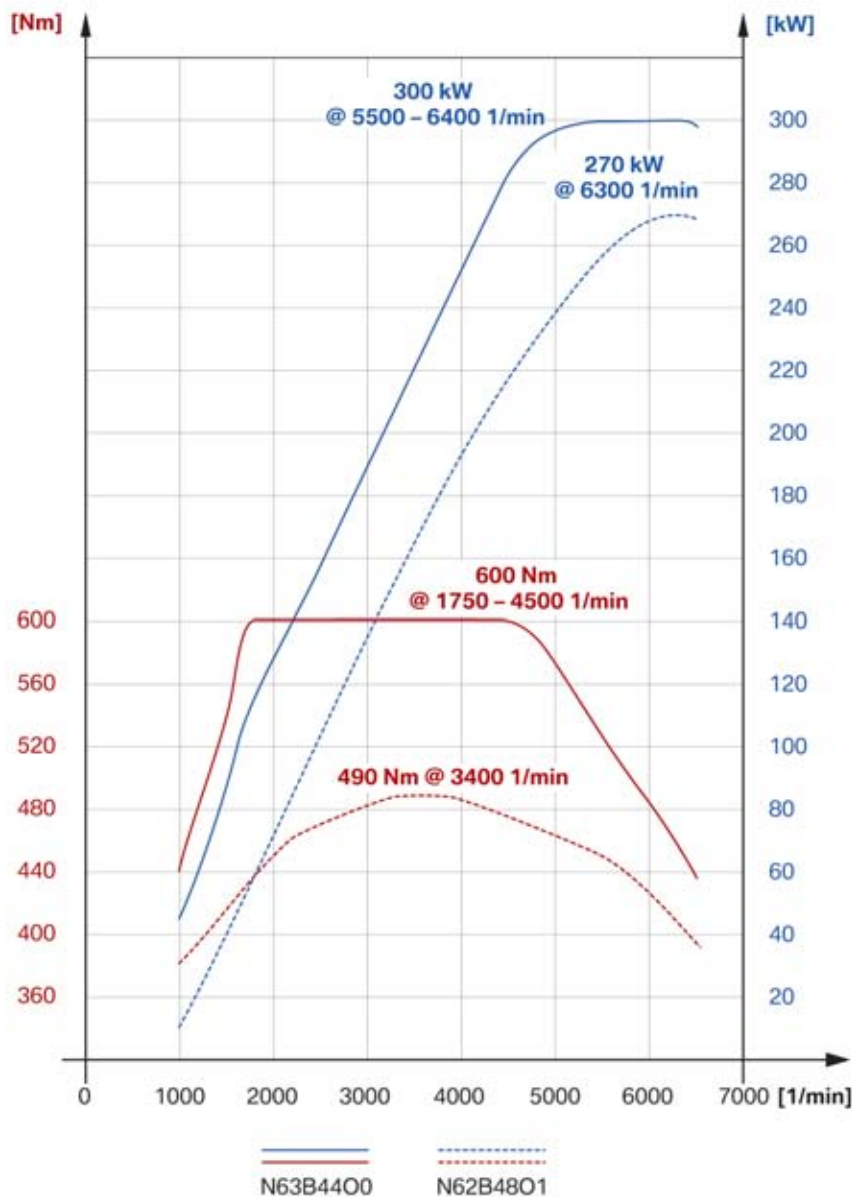


# F12 Powertrain

## 2. Engine

### 2.1.2. Full load diagram

Compared to its predecessor the N62 engine, the N63 engine is characterized by a significantly higher overall power output and boasts a linear torque curve.



TO09-2254

Full load diagram of E64 650i with N62B4801 engine compared to F12 650i with N63B4400 engine.

# F12 Powertrain

## 2. Engine

### 2.2. Engine designation and engine identification

#### 2.2.1. Engine designation

In the technical documentation, the engine designation is used to ensure unambiguous identification of the engine. In frequent cases, however, only a short designation is used. This short form is used so an engine can be identified as belonging to a specific engine family.

Item	Meaning	Index	Explanation
1	Engine developer	M, N P S W	BMW Group BMW M Sport BMW M GmbH Bought-in engines
2	Engine type	1 4 5 6 7 8	4-cylinder in-line engine (e.g. N12) 4-cylinder in-line engine (e.g. N43) 6-cylinder in-line engine (e.g. N55) V8 engine (e.g. N63) V12 engine (e.g. N74) V10 engine (e.g. S85)
3	Change to the basic engine concept	0 1 – 9	Basic engine Changes, e.g. combustion process
4	Working method or fuel type and possibly installation position	B D H	gasoline, longitudinally mounted Diesel, longitudinally mounted Hydrogen
5 + 6	Displacement in 1/10 liter	30	3.0 liter
7	Performance class	K U M O T S	Lowest Lower Middle Upper (standard) Top Super
8	Revision relevant to approval	0 1 – 9	New development Redesign

# F12 Powertrain

## 2. Engine

### 2.2.2. Engine identification

The engines have an identification mark on the crankcase to ensure unambiguous identification and classification.

This engine identification is also necessary for approval by government authorities. With the N55 engine, this identification has been subject to a further development, with the previous eight positions being reduced to seven. The engine number can be found on the engine below the engine identification. This consecutive number, in conjunction with the engine identification, permits unambiguous identification of each individual engine.

Item	Meaning	Index	Explanation
1	Engine developer	M, N P S W	BMW Group BMW M Sport BMW M GmbH Bought-in engines
2	Engine type	1 4 5 6 7 8	4-cylinder in-line engine (e.g. N12) 4-cylinder in-line engine (e.g. N43) 6-cylinder in-line engine (e.g. N55) V8 engine (e.g. N63) V12 engine (e.g. N74) V10 engine (e.g. S85)
3	Change to the basic engine concept	0 1 – 9	Basic engine Changes, e.g. combustion process
4	Working method or fuel type and possibly installation position	B D H	gasoline, longitudinally mounted Diesel, longitudinally mounted Hydrogen
5 + 6	Displacement in 1/10 liter	30	3.0 liter
7	Type approval matters (changes which require a new type approval)	A B – Z	Standard As required, e.g. RON87

# F12 Powertrain

## 3. Automatic transmission

### 3.1. Designation

A unique designation is used for the transmission in the technical documentation so it can be clearly identified. In frequent cases, however, only a short designation is used. This short form is used so the transmission can be assigned to a transmission family. The GA8HP transmission family, consisting of the GA8HP45Z, GA8HP70Z and GA8HP90Z transmissions for example, is often mentioned.

Item	Meaning	Index	Explanation
1	Designation	G	Transmission
2	Type of transmission	A	Automatic transmission
3	Number of gears	6 8	Six forward gears Eight forward gears
4	Type of transmission	HP L R	Hydraulic planetary gear train Designation of General Motors Powertrain Designation of General Motors Powertrain
5 + 6	Transferable torque	19 26 32 45 (Zahnradfabrik Friedrichshafen) 45 (General Motors Powertrain) 70 90 390	300 Nm gasoline engine 600 Nm gasoline engine 720 Nm gasoline engine 450 Nm gasoline engine, 500 Nm diesel engine 350 Nm gasoline engine 700 Nm gasoline engine and diesel engine 900 Nm gasoline engine 390 Nm, 4th gear 410 Nm, gasoline engine
7	Manufacturer	G J R Z H	Getrag Jatco General Motors Powertrain Zahnradfabrik Friedrichshafen In-house part

### 3.2. Variants

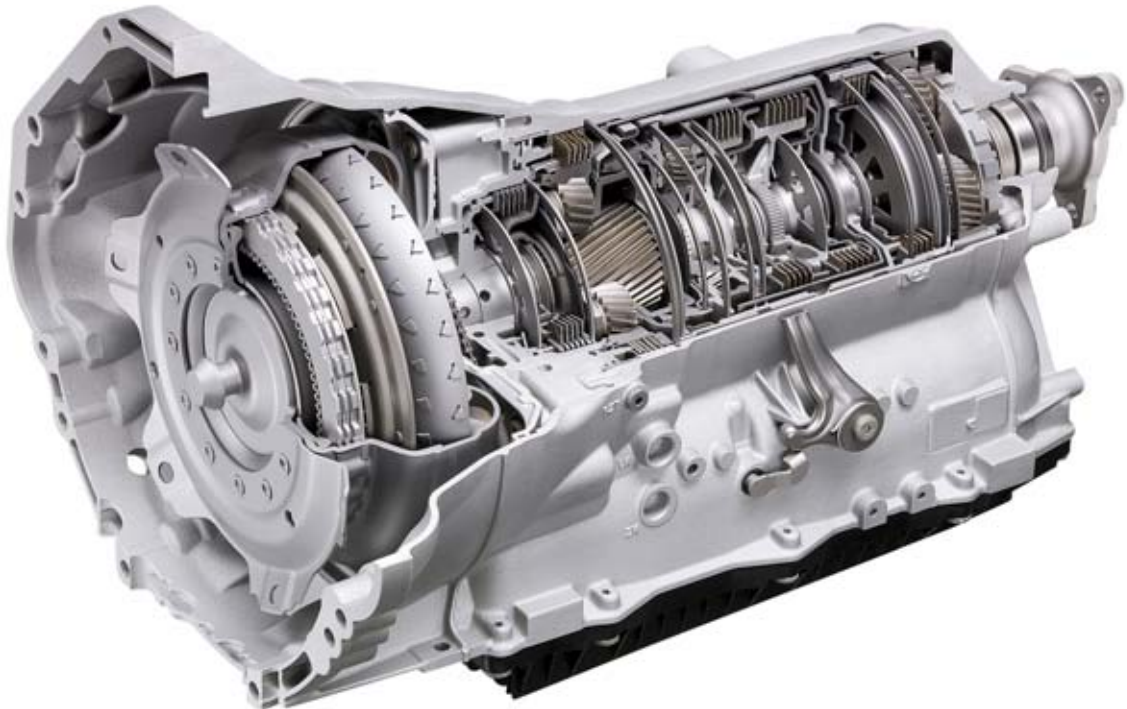
Model	Engine	Transmission	Torque converter
650i	N63B4400	GA8HP70Z	NW250H227TTD1

### 3.3. GA8HP transmission

The new GA8HP45Z and GA8HP70Z automatic transmissions with eight forward gears and one reverse gear are used in the F12.

# F12 Powertrain

## 3. Automatic transmission



TA09-1361

### Special features:

- Enhanced gearshift spontaneity
- Greater driving and shifting comfort as a result of a closer gear ratio
- Higher precision control of the converter lockup clutch at low engine loads
- High power transmission of the converter lockup clutch
- Reduced fuel consumption (-5% to -6%)

The GA8HP45Z and GA8HP70Z are new developments and will gradually replace the established 6-speed automatic transmissions GA6HP19Z TU and GA6HP26Z TU. The overall gear ratio has been increased from 6.04 to 7.07; the gear to gear ratios have now become closer, thus also reducing the differences in speed when shifting gear. The weight of the transmission has been reduced significantly using a plastic oil pan and other light weight components.

The Electronic Transmission Control (EGS) control unit is integrated in the control unit framework of the electronic immobilizer EWS. This provides better protection against theft.

It is operated via the gear selector switch or using the shift paddles (SA 2TB, automatic sports transmission, via the steering column switch cluster (SZL)).

Mechanical torsional vibration dampers of the second generation are deployed in the torque converter:

- Turbine torsional vibration damper TTD
- Two-damper torque converter ZDW. (used on diesel applications of this transmission)

# F12 Powertrain

## 3. Automatic transmission

The function and structure of the torque converter are described in the “E70 Automatic transmission” training material available on TIS and ICP.

The vibration isolation reduces the proportion of slip on the converter lockup clutch and enables a larger operating range with the converter lockup clutch closed. This reduces the fuel consumption by 5% to 6% in the consumption cycle (KV01) compared to the TU 6-speed automatic transmission used until now.

### 3.3.1. Technical data

		<b>GA8HP70Z</b>
Maximum power	kW/ bhp	380/509
Maximum torque	Nm/ ft- lbs	700/516
Maximum permissible engine speed, 1st - 7th gear	[rpm	7200
Maximum permissible engine speed, 8th gear	[rpm	5700
Maximum permissible engine speed, reverse gear	[rpm	3500
Ratio, 1st gear		4.70
Ratio, 2nd gear		3.13
Ratio, 3rd gear		2.10
Ratio, 4th gear		1.67
Ratio, 5th gear		1.29
Ratio, 6th gear		1.00
Ratio, 7th gear		0.84
Ratio, 8th gear		0.67
Ratio, reverse gear		3.30

### 3.4. Transmission emergency release

The F12 features the new control concept for operation of the mechanical transmission emergency release. The transmission emergency release is no longer “mechanically” operated from the passenger compartment.

#### 3.4.1. Mechanical transmission emergency release

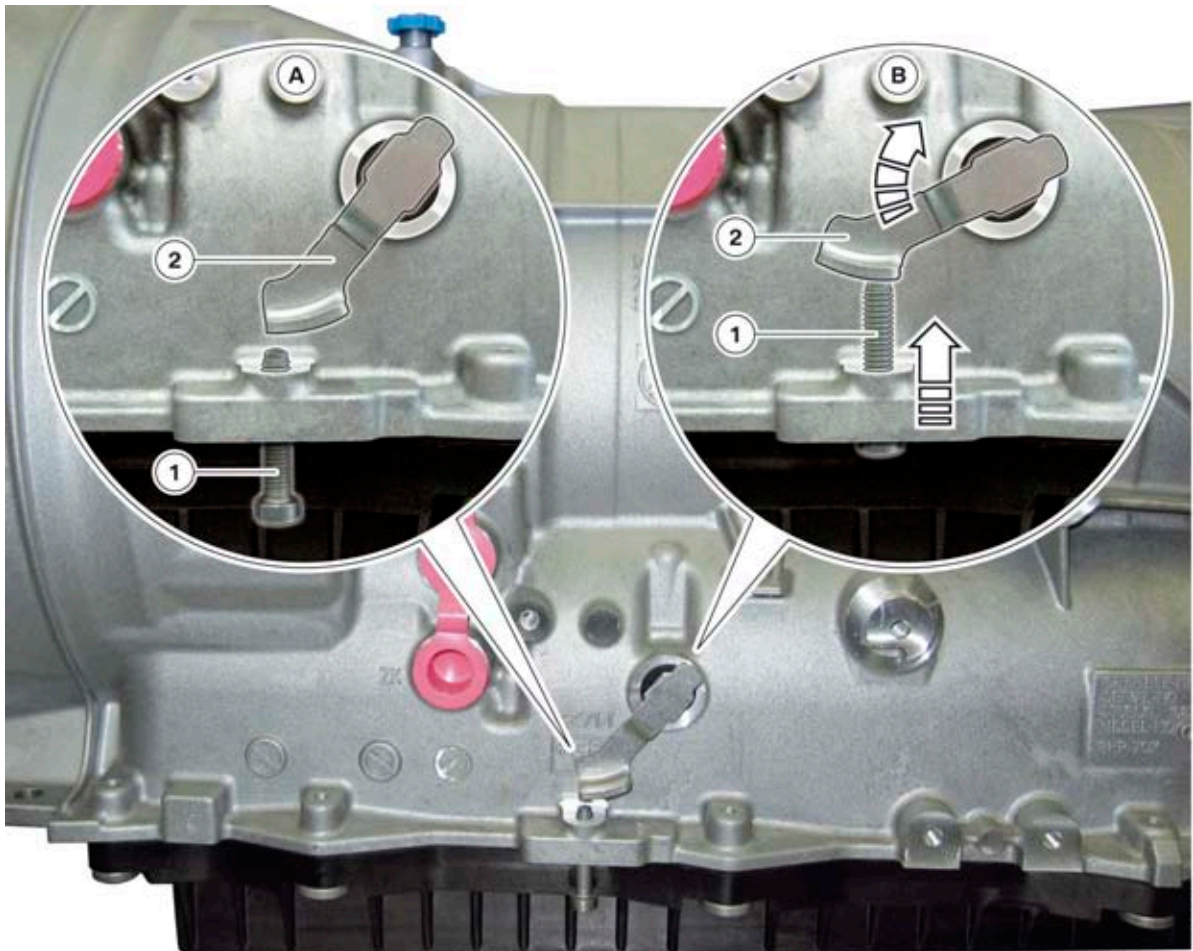


The mechanical transmission emergency release may only be operated by specially trained Service personnel.

# F12 Powertrain

## 3. Automatic transmission

To actuate mechanical transmission emergency release, it is necessary to raise the vehicle and remove the underbody panelling.



F12 Mechanical transmission emergency release GA8HP

Index	Explanation
1	Adjusting screw
2	Parking lock lever
A	Transmission parking lock engaged
B	Transmission parking lock released

In the event of a fault, the automatic transmission parking lock can be disabled via a mechanical emergency release function by turning an adjusting screw located directly on the transmission shift linkage. This mechanism is only accessible from underneath the vehicle and in some cases the belly pan may have to be removed.

For detailed information on the mechanical transmission emergency release, refer to the corresponding repair instructions.



# F12 Powertrain

## 3. Automatic transmission

### 3.4.2. Electronic transmission emergency release



Only specially trained service technicians are permitted to actuate electronic transmission emergency release.

The vehicle must not be towed while electronic transmission emergency release is actuated; it may only be maneuvered. In case of misuse an entry is made in the fault memory.



The electronic transmission emergency release can only be operated if the engine does not start but the starter motor still turns.

The electronic transmission emergency release function is active for fifteen minutes. This time is extended by a further 15 minutes as soon as a wheel speed signal is recorded. After this time period the parking lock is engaged without a Check Control message being displayed. The time specified is dependent on the battery capacity.

- Before operating the electronic transmission emergency release, secure the vehicle to prevent it from rolling
- Depress and hold the brake pedal throughout the entire process
- Press the start/stop button-the starter motor will crank for a specific amount of time



Electronic emergency release for GA8HP transmission, using F25 as example

Index	Explanation
1	Release button
2	Gear selector switch



# F12 Powertrain

## 3. Automatic transmission

- Press the shifter release button (1) and hold it pressed
- Move gear selector switch (2) forwards one step (not all the way!) and hold it there for **two seconds** (no more, no less)
- Release the gear selector switch (2) and move it forwards again briefly one step (not all the way!)  
When the transmission position "N" is displayed in the instrument panel (KOMBI) - the transmission is unlocked electronically



If the start/stop button is pressed again, the parking lock is reactivated without a Check Control message being displayed.

For detailed information on the electronic transmission emergency release, refer to the corresponding repair instructions.

### 3.5. Gear selector switch

The F12 features the gear selector switch already familiar from the F10.



F12 Gear selector switch

# F12 Powertrain

## 4. Manual transmission

### 4.1. Designation

The transmission designation in the technical documentation allows it to be uniquely identified. In frequent cases, however, only a short designation such as I, K, or G is used to identify the transmission. For the correct designation, refer to the following table.

Item	Meaning	Index	Explanation
1	Designation	G	Transmission
2	Type of transmission	S	Manual gearbox
3	Number of gears	1 – 9	Number of forward gears
4	Type of transmission	-	Manual transmission
		X	All-wheel drive vehicle with manual transmission
		S	Sequential Manual Gearbox SMG
		W	All-wheel drive vehicle with sequential manual transmission
		D	Twin-clutch gearbox
		Y	All-wheel drive vehicle with twin-clutch gearbox
5 + 6	Transmission type	17	I transmission
		26	D transmission
		37	H transmission
		45	K transmission
		53	G transmission
7	Gear set	B	Gasoline engine ratio
		D	Diesel engine ratio (w)
		S	Sport ratio
		P	gasoline engine ratio, revised
8	Manufacturer	G	Getrag
		J	Jatco
		R	General Motors Powertrain
		Z	Zahnradfabrik Friedrichshafen
		H	In-house part

### 4.2. Variants

Model	Engine	Manual gearbox	
650i	N63B44O0	G	GS6-53BZ

### 4.3. G manual transmission

The G manual transmission familiar from the E60 with N62 engine has been further developed for used in the F12 650i with N63 engine. The maximum drive torque has been increased from 490 Nm to 600 Nm.

# F12 Powertrain

## 4. Manual transmission

This means that an extremely high degree of precision, operational smoothness and top class shifting comfort are tangible to the customer. The total ratio spread of the transmission maximizes the utilization of engine performance. The shifting comfort is significantly higher, due in part to the short shift travel distances of 55 mm.

### Special features:

- Slip suppression control system to prevent clutch slip
- Start-up engine speed limitation in order to minimize the work required to overcome friction of the clutch (in conjunction with the N63 engine)
- External transmission oil cooling (in conjunction with the N63 engine)
- Use of long term oil filling.

A slip suppression control system is installed to prevent possible overloading of the clutch. This makes acceleration under full load conditions possible without the clutch slipping. The clutch slip is calculated via an engine speed pickup at the transmission countershaft and the engine torque is reduced as required.

A start-up engine speed limitation system is used in conjunction with the N63 engine. This limits the engine speed to 3500 – 5500 rpm when the vehicle is at a standstill, depending on the mode of the Dynamic Stability Control (DSC), which prevents thermal overloading of the drive plate during the starting process.

In conjunction with the N63 engine, the external transmission oil cooling system ensures that the vehicle operates reliably, even under extreme conditions. To achieve this, the transmission oil is pumped through the transmission oil cooler by a transmission oil pump to cool it. The transmission has an integrated gearbox oil temperature sensor via which the transmission oil pump is switched on (transmission oil temperature > 130 °C) or off (transmission oil temperature < 110 °C).

### 4.3.1. Technical data

		<b>G transmission GS6-53BZ</b>
Engine applications in F12		N63B4400
Maximum drive torque	Nm/ft-lbs	600/450
Wheelbase	[mm]	94.96
Weight with oil	kg/lbs	57.6/126.7
Oil quantity	[l]	2.2
Transmission length	[mm]	669
Ratio, 1st gear		4.055
Ratio, 2nd gear		2.396
Ratio, 3rd gear		1.582
Ratio, 4th gear		1.192
Ratio, 5th gear		1.000

# F12 Powertrain

## 4. Manual transmission

---

	<b>G transmission GS6-53BZ</b>
Ratio, 6th gear	0.872
Ratio, reverse gear	3.677
Axle ratio	3.08

---

### 4.4. Gearshift

#### Special features:

- Further development of typical BMW gearshift
- Improved shifting force characteristics and shifting precision
- New gearshift arm concept, harmonized with innovative center console design
- New sporty design of single-piece gearshift lever knob with leather cover
- New "Dakota" leather material (improved longevity and optics)
- Ergonomically-optimized harmonization of center console and gearshift knob position
- Optimum ergonomics with different versions for left and right-hand drive vehicles

The rod gearshift system and tried-and-tested concept of direct connection to the transmission have been retained.

# F12 Powertrain

## 5. Rear axle final drive

### 5.1. Designation

Item	Meaning	Index	Explanation
1 – 3	Type of transmission	HAG	Rear axle final drive
4 – 6	Overall size	205 225	Diameter of crown wheel pitch circle in mm
7	Housing type	A	Aluminium
8	Type of transmission	L	Smooth running

### 5.2. Variants

Model	Transmission	Rear axle final drive	Gear ratio $i$
650i	GS6-53BZ	HAG 225AL	3.08
650i	GA8HP70Z	HAG 225AL	3.08

### 5.3. Lightweight construction, rear axle final drive

As is the case in the F01, F07 and F10, the new rear axle final drive HAG 225AL with aluminium housing is installed.



F12 Lightweight construction, rear axle final drive

#### Special features:

- Lower weight  
HAG 225AL: 29.7 kg (incl. oil)
- Greater power transmission
- Better efficiency.

# F12 Powertrain

## 6. Driveshafts

### 6.1. Driveshaft

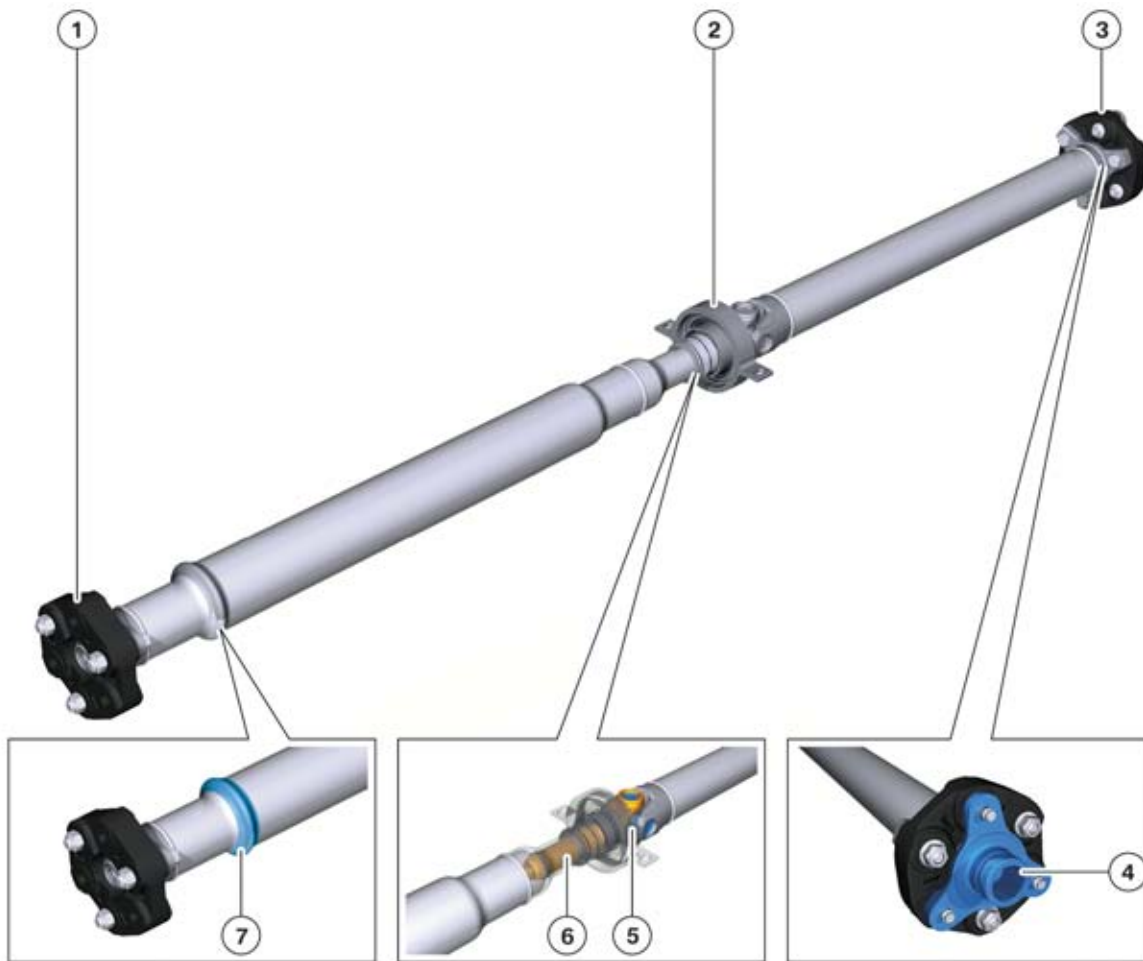
#### 6.1.1. Overview

Two variants of the steel driveshaft are used depending engine-transmission configuration.

Special focal points of the F12 driveshaft design were the torque transfer and comfort requirements in relation to acoustics and vibrations.

The joints, shaft divisions and shaft diameters have been designed to prevent disruptive noises or vibrations being passed on through the connection points to the body.

The F12 driveshafts are connected to the manual or automatic transmission and to the rear axle final drive exclusively using flexible discs. This minimizes the high-frequency gear meshing noises on the rear axle final drive.



TK09-2042

F12 Propeller shaft

# F12 Powertrain

## 6. Driveshafts

Index	Explanation
1	Flexible disc (at automatic or manual transmission)
2	Center mount
3	Flexible disc (on rear axle final drive)
4	Plug connection
5	Universal joint
6	Collapsing element connection
7	Crash function

### 6.1.2. Crash function

In the event of a head-on collision, the driveshaft absorbs a portion of the crash energy. The properties of the so-called crash function, which is integrated in the front driveshaft tube, have been optimized. The force at which the front driveshaft tube selectively deforms has been reduced once again compared to the E63. The torque transfer capability has remained unchanged.

## 6.2. Output shafts

### 6.2.1. Designation

Item	Meaning	Index	Explanation
1 + 2	Joint type	VL	Löbro sliding joint
3 – 7	Designation	3300i 4100i	Identification, construction size/transfer capability

### 6.2.2. Variants

Model	Transmission	Rear axle final drive	Output shaft
650i	GS6-53BZ	HAG 225AL	VL-4100i
650i	GA8HP70Z	HAG 225AL	VL-3300i

### 6.2.3. Overview



TA09-1364

F12 Output shaft

# F12 Powertrain

## 6. Driveshafts

The F12 features output shafts that are inserted onto the gear and differential side.

The journal version towards the rear axle final drive depends on the size of the rear axle final drive. The journal to the wheel hub is designed in only one size.

The positioning of the rear axle final drive means the left and right output shafts have different overall lengths.

The splined shaft between the two joints is designed as a torsionally-rigid hollow shaft.







Bayerische Motorenwerke Aktiengesellschaft  
Händlerqualifizierung und Training  
Röntgenstraße 7  
85716 Unterschleißheim, Germany